AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (Currently Amended) A method for generating electromagnetic radiation comprising:

producing free electrons;

selecting from said free electrons a group of electrons having ~~a reduced~~ an energy spread less than the remaining of said free electrons; and

undulating the group of free electrons with an undulator in an undulation zone, said undulator having an intensity sufficient to cause the emission of radiation from the group of electrons and causing the electron radiation to interact with radiation from the undulator to bunch the group of electrons, whereby such bunching generates further emission of radiation, wherein said selecting is accomplished by magnetic filtering and said magnetic filtering is accompanied by refocusing of the electron beam to the undulation zone.

2. (Original) A method of Claim 1, wherein said producing of free electrons includes accelerating free electrons by means of an electron beam in a plasma.

3. (Original) A method of Claim 1, wherein said producing of free electrons includes accelerating free electrons in a plasma.

4. (Original) A method of Claim 1, wherein said producing of free electrons includes accelerating free electrons by means of a laser in a plasma.

5. (Original) A method of Claim 4, wherein the accelerating is accomplished at least in part by a plasma wakefield.

6. (Original) A method of Claim 5, wherein the accelerating is assisted by a direct-current (DC) electric field.

7. (Currently Amended) A method ~~of Claim 1~~ for generating electromagnetic radiation comprising:

producing free electrons;

selecting from said free electrons a group of electrons having an energy spread less than the remaining of said free electrons; and

undulating the group of free electrons with an undulator in an undulation zone, said undulator having an intensity sufficient to cause the emission of radiation from the group of electrons and causing the electron radiation to interact with radiation from the undulator to bunch the group of electrons, whereby such bunching generates further emission of radiation, wherein before said undulating, a beam of at least one pulse of electromagnetic radiation is produced; and wherein said free electrons and pulse of electromagnetic radiation coincide during said undulating to further enhance emission of radiation.

8. (Original) A method of Claim 7, wherein said undulating constitutes a first stage of undulating for said group of free electrons that is a first group of free electrons; a second group of free electrons is produced; and radiation from said first stage of undulating is added to a second stage of undulating comprising the undulating of the second group of free electrons.

9. (Original) A method of Claim 1, wherein said undulating is accomplished by an electromagnetic laser wiggler.

10. (Original) A method of Claim 1, wherein said undulating is accomplished by a magnetostatic undulator.

11-14. (Canceled)

15. (Currently Amended) A method ~~of Claim 14,~~ for generating electromagnetic radiation comprising:

producing free electrons;

selecting from said free electrons a group of electrons having an energy spread less than the remaining of said free electrons; and

undulating the group of free electrons with an undulator in an undulation zone, said undulator having an intensity sufficient to cause the emission of radiation from the group of electrons and causing the electron radiation to interact with radiation from the undulator to bunch the group of electrons, whereby such bunching generates further emission of radiation,

wherein said selecting is accomplished by preferentially accelerating those electrons in said group of electrons by means of optical injection, comprising generating a plasma and introducing additional laser pulses in the plasma, and wherein said preferential acceleration is accomplished by means of a sharp density discontinuity within the plasma.

16-22. (Canceled)

23. (Currently Amended) The method of Claim 1, wherein said selecting is accomplished by preferentially accelerating those electrons of said group ~~having a narrow energy range~~.

24. (Canceled)

25. (Original) The method of Claim 1, wherein said emission of radiation is at a fundamental frequency.

26. (Currently Amended) The method ~~of Claim 1~~ for generating electromagnetic radiation comprising:

producing free electrons;

selecting from said free electrons a group of electrons having an energy spread less than the remaining of said free electrons; and

undulating the group of free electrons with an undulator in an undulation zone, said undulator having an intensity sufficient to cause the emission of radiation from the group of electrons and causing the electron radiation to interact with radiation from the undulator to bunch the group of electrons, whereby such bunching generates further emission of radiation, wherein said emission of radiation comprises multiple frequencies that are multiples of a fundamental frequency.

27. (Original) The method of Claim 26, wherein said multiple frequencies are generated by said undulator characterized by a field strength that is essentially non-sinusoidal.

28-43. (Canceled)

44. (Currently Amended) The method ~~of Claim 28~~ for generating electromagnetic radiation comprising: producing a group of free electrons, undulating the group of free electrons and causing emission of radiation, wherein said emission of radiation comprises multiple frequencies that are multiples of a fundamental frequency.

45. (Original) The method of Claim 44, wherein said multiple frequencies are generated by said undulator characterized by a field strength that is essentially non-sinusoidal.

46. (Original) A method for generating electromagnetic radiation comprising: generating a first group of free electrons and separately generating seed radiation; undulating the first group of free electrons in the presence of the seed radiation, thereby producing first amplified radiation; generating a second group of free electrons; and undulating the second group of free electrons and the first amplified radiation in a second undulator to produce second amplified radiation.

47. (Original) A method for generating electromagnetic radiation comprising:

(a) generating a group of free electrons and separately generating seed radiation; undulating the group of free electrons in the presence of the seed radiation, thereby producing upstream amplified radiation; and

(b) generating a further group of free electrons, and undulating the further group of free electrons and the upstream amplified radiation in a downstream undulator to produce a downstream amplified radiation.

48. (Original) The method of Claim 47, wherein Step (b) is repeated for a multi-staged amplification of three stages or more.

49. (Currently Amended) A method for generating electromagnetic radiation comprising: producing a first group of free electrons having a first energy spread; undulating a second group of free electrons from among said first group of free electrons, said second group of free electrons having a ~~reduced~~ second energy spread, said second energy spread being less than said first energy spread ~~as compared to said first group~~; where said undulator has an intensity sufficient to cause the emission of radiation from the second group of electrons and causes the electron radiation to interact with radiation from the undulator.

50-61. (Canceled)

62. (Original) A method to generate electromagnetic radiation comprising: producing free electrons; arranging said free electrons into groups of free electrons having corresponding different energy ranges and spatially separating said groups; and undulating the groups of free electrons essentially simultaneously with respective undulators, said undulators each having an intensity sufficient to cause the emission of radiation from a respective one of said groups of free electrons and causing the electron radiation to interact with radiation from the undulator to bunch the electrons of a respective said group, whereby such bunching generates further emission of radiation of differing wavelengths corresponding to said groups respectively.

63. (Original) A method of generating electromagnetic radiation comprising: producing free electrons arranged in spatially separate groups of free electrons having essentially non-overlapping energy ranges; and undulating the spatially separate groups of free electrons essentially simultaneously, causing emission of radiation at various wavelengths.

64. (Original) The method of Claim 1, wherein said producing of free electrons comprises photo-ionization of one or more selected from the group consisting of gas, liquid and solid.

65. (Original) The method of Claim 2, wherein said plasma is produced by photo-ionization of one or more selected from the group consisting of gas, liquid and solid.

66. (Original) The method of Claim 8, wherein said radiation from said first stage of undulating is collected and focused with x-ray optics before being added to said second stage of undulating.

67. (Original) The method of Claim 66, wherein said focusing is by at least one selected from the group consisting of curved mirrors, zone plates and capillary fibers.

68. (Original) An apparatus for generating electromagnetic radiation comprising:

(a) a source of a group of free electrons;

(b) a source of seed radiation;

(c) an undulator for undulating the group of free electrons in the presence of the seed radiation, thereby producing upstream amplified radiation;

(d) a source of a further group of free electrons; and

(e) a downstream undulator for undulating the further group of free electrons and the upstream amplified radiation to produce a downstream amplified radiation.

69. (Original) The apparatus of Claim 68, having one or more additional downstream undulators for a multi-staged amplification of three stages or more.

70. (Original) The apparatus of Claim 68 that comprises a collector for collecting said upstream radiation and x-ray optics for focusing said upstream radiation, said collector and x-ray optics arranged to direct said upstream radiation to said downstream undulator.